

Inter**Lab**[®]

Final Report on

Lock8 G1

FCC ID 2AFPAL8G10843

Report Reference:

MDE_VELO_1401_FCCa
acc. Title 47 CFR chapter I part 15 subpart C

Date:

September 04, 2015

Test Laboratory:

7layers GmbH
Borsigstraße 11
40880 Ratingen
Germany



Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in part without the written approval of the test laboratory.

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Managing Director:
Dr. Harald Ansorge

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USt-IdNr VAT No.:
DE203159652
TAX No. 147/5869/0385
A Bureau Veritas Group Company

1 Administrative Data

1.1 Project Data

Project Responsible: Dirk Bratsch
Date Of Test Report: 2015/09/04
Date of first test: 2015/08/25
Date of last test: 2015/09/04

1.2 Applicant Data

Company Name: Velolock Germany GmbH
Street: Rosenthaler Strasse 13
10119 Berlin
Country: Germany
Contact Person: Mr. Roman Laabs
Function: Production Manager
Phone: +49. 30. 400 406 - 14
Mobile: +49. 176 25297394
E-Mail: roman.laabs@lock8.me

1.3 Test Laboratory Data

The following list shows all places and laboratories involved for test result generation:

7 layers DE

Company Name : 7 layers GmbH
Street : Borsigstrasse 11
City : 40880 Ratingen
Country : Germany
Contact Person : Mr. Michael Albert
Phone : +49 2102 749 201
Fax : +49 2102 749 444
E Mail : Michael.Albert@7Layers.com

Laboratory Details

Lab ID	Identification	Responsible	Accreditation Info
Lab 1	Conducted Emissions	Mr. Andreas Petz Mr. Wolfgang Richter	DAkkS-Registration no. D-PL-12140-01-01
Lab 2	Radiated Emissions	Mr. Marco Kullik Mr. Robert Machulec	DAkkS-Registration no. D-PL-12140-01-01
Lab 3	Regulatory Bluetooth RF Test Solution	Mr. Jimmy Chatheril Mr. Sören Berentzen	DAkkS-Registration no. D-PL-12140-01-01

1.4 Signature of the Testing Responsible



Imad Hjije
responsible for tests performed in: Lab 1, Lab 2, Lab 3

1.5 Signature of the Accreditation Responsible



Bernhard Retka

Accreditation scope responsible person
responsible for Lab 1, Lab 2, Lab 3

2 Test Object Data

2.1 General OUT Description

The following section lists all OUTs (Object's Under Test) involved during testing.

OUT: LOCK8 G1

Type / Model / Family:	Lock8 G1
	FCC ID 2AFPAL8G10843
Product Category:	Others
Manufacturer:	
Company Name:	Please see applicant data
Contact Person:	-

Parameter List:

Parameter name	Value
Parameter for Scope FCC_v2:	
AC Power Supply	120 (V)
Antenna Gain	5.3 dBi
DC Power Supply	3 (V)
highest channel (BT)	2480 (MHz)
lowest channel (BT)	2402 (MHz)
mid channel (BT)	2440 (MHz)

2.2 Detailed Description of OUT Samples

Sample : aa01

<i>OUT Identifier</i>	LOCK8 G1		
<i>Sample Description</i>	Conducted Sample #01		
<i>Serial No.</i>	2077		
<i>HW Status</i>	v8.4.3		
<i>SW Status</i>	V1.0		
<i>Low Voltage</i>	2.1 V	<i>Low Temp.</i>	-40 °C
<i>High Voltage</i>	3.6 V	<i>High Temp.</i>	80 °C
<i>Nominal Voltage</i>	3 V	<i>Normal Temp.</i>	25 °C

Parameter List:

<i>Parameter Description</i>	<i>Value</i>
Parameter for Scope FCC_v2	
Antenna Gain	5.3 (dBi)
Frequency_high	2480 (MHz)
Frequency_low	2402 (MHz)
Frequency_mid	2440 (MHz)

Sample : ab01

<i>OUT Identifier</i>	LOCK8 G1		
<i>Sample Description</i>	Sample #01 SIM Panel		
<i>Serial No.</i>	2076		
<i>HW Status</i>	v8.4.3		
<i>SW Status</i>	V1.0		
<i>Low Voltage</i>	2.1 V	<i>Low Temp.</i>	-40 °C
<i>High Voltage</i>	3.6 V	<i>High Temp.</i>	80 °C
<i>Nominal Voltage</i>	3 V	<i>Normal Temp.</i>	25 °C

Parameter List:

<i>Parameter Description</i>	<i>Value</i>
Parameter for Scope FCC_v2	
Antenna Gain	5.3 (dBi)
Frequency_high	2480 (MHz)
Frequency_low	2402 (MHz)
Frequency_mid	2440 (MHz)

Sample : ac01

OUT Identifier	LOCK8 G1		
Sample Description	Sample #02		
Serial No.	2079		
HW Status	v8.4.3		
SW Status	V1.0		
Low Voltage	2.1 V	Low Temp.	-40 °C
High Voltage	3.6 V	High Temp.	80 °C
Nominal Voltage	3 V	Normal Temp.	25 °C

Parameter List:

Parameter Description	Value
Parameter for Scope FCC_v2	
Antenna Gain	5.3 (dBi)
Frequency_high	2480 (MHz)
Frequency_low	2402 (MHz)
Frequency_mid	2440 (MHz)

2.3 OUT Features

Features for OUT: LOCK8 G1

Designation	Description	Allowed Values	Supported Value(s)
Features for scope: FCC_v2			
AC	The OUT is powered by or connected to AC Mains		
BT	EUT supports Bluetooth data rate of 1 Mbps with GFSK modulation in the band 2400 MHz - 2483.5 MHz		
DC	The OUT is powered by or connected to DC		
Iant	Integral Antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment		
TantC	temporary antenna connector, which may be only built-in for testing, designed as an example part of the equipment		

2.4 Auxiliary Equipment

AE No.	Type Designation	Serial No.	HW Status	SW Status	Description
AE 02	ABUS cable with custom cable pin	L8-G1-831-60001			Spiral cable
AE 03	Aluminium clamp bracket	L8-G1-831-50000			Standard clamp model
AE 01	VEL05US060-US-JA				AC/DC Charger

2.5 Setups used for Testing

For each setup a relation is given to determine if and which samples and auxiliary equipment is used.
The left side list all OUT samples and the right side lists all auxiliary equipment for the given setup.

Setup No.	List of OUT samples		List of auxiliary equipment	
Sample No.	Sample Description		AE No.	AE Description
S01_AA01 (Conducted Setup)				
Sample:	aa01	Conducted Sample #01	AE 02	Spiral cable
			AE 03	Standard clamp model
			AE 01	AC/DC Charger
S01_AB01 (Setup #01 SIM Panel)				
Sample:	ab01	Sample #01 SIM Panel	AE 02	Spiral cable
			AE 03	Standard clamp model
			AE 01	AC/DC Charger
S01_AC01 (Setup #02)				
Sample:	ac01	Sample #02	AE 02	Spiral cable
			AE 03	Standard clamp model
			AE 01	AC/DC Charger

3 Results

3.1 General

Documentation of tested devices:

Available at the test laboratory.

Interpretation of the test results:

The results of the inspection are described on the following pages, where 'Conformity' or 'Passed' means that the certification criteria were verified and that the tested device is conform to the applied standard.

In cases where 'Declaration' is printed, the required documents are available in the manufacturers product documentation.

In cases where 'not applicable' is printed, the test case requirements are not relevant to the specific equipment implementation.

Note:

1. All tests are performed under environmental conditions within the requirements of the specifications. Environmental conditions are available at the laboratory.
2. The device is a remot control containing a BTLE Transceiver operating in the 2.4 GHz ISM band.

3.2 List of the Applicable Body

(Body for Scope: FCC_v1)

(Body for Scope: FCC_v2)

<i>Designation</i>	<i>Description</i>
FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES	Subpart C - Intentional Radiators; 15.231 Periodic operation in the band 40.66 - 40.70 MHz and above 70 MHz.

3.3 List of Test Specification

<i>Test Specification:</i>	FCC part 2 and 15
<i>Version</i>	10-1-13 Edition
<i>Title:</i>	PART 2 - GENERAL RULES AND REGULATIONS PART 15 - RADIO FREQUENCY DEVICES

3.4 Summary

<i>Test Case Identifier / Name</i>	<i>Result</i>	<i>Date of Test</i>	<i>Lab</i>	<i>Setup</i>
<i>Test (condition)</i>			<i>Ref.</i>	
15c.1 Conducted emissions (AC power line) §15.207				
15c.1 Conducted emissions (AC power line)	Passed	2015/08/25	Lab 1	S01_AB01
15c.10 Power density §15.247 (e)				
15c.10; Frequency = Low/Mid/High	Passed	2015/09/04	Lab 3	S01_AA01
15c.11 6dB Bandwidth §15.247 (a) (2)				
15c.11; Frequency = Low/Mid/High	Passed	2015/09/04	Lab 3	S01_AA01
15c.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209				
15c.2 Spurious radiated emissions, highest channel, BT	Passed	2015/08/26	Lab 2	S01_AB01
15c.2 Spurious radiated emissions, lowest channel, BT	Passed	2015/09/03	Lab 2	S01_AC01
15c.2 Spurious radiated emissions, mid channel, BT	Passed	2015/08/26	Lab 2	S01_AB01
15c.4 Peak power output §15.247 (b) (1)				
15c.4; Peak power output Summary	Passed	2015/09/04	Lab 3	S01_AA01
15c.5 Spurious RF conducted emissions §15.247 (d)				
15c.5 Spurious RF conducted emissions, highest channel, BT	Passed	2015/09/04	Lab 3	S01_AA01
15c.5 Spurious RF conducted emissions, lowest channel, BT	Passed	2015/09/04	Lab 3	S01_AA01
15c.5 Spurious RF conducted emissions, mid channel, BT	Passed	2015/09/04	Lab 3	S01_AA01
15c.6 Band edge compliance §15.247 (d)				
15c.6 Band edge compliance, highest channel, BT	Passed	2015/09/04	Lab 3	S01_AA01
15c.6 Band edge compliance, lowest channel, BT	Passed	2015/09/04	Lab 3	S01_AA01
15c.6; Frequency = 2480, Mode = Bluetooth Low Energy	Passed	2015/08/26	Lab 2	S01_AB01

3.5 Detailed Results

3.5.1 15c.1 Conducted emissions (AC power line) §15.207

Test: 15c.1 Conducted emissions (AC power line)

Result:	Passed
Setup No.:	S01_AB01
Date of Test:	2015/08/25 17:14
Body:	FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
Test Specification:	FCC part 2 and 15

Detailed Results:

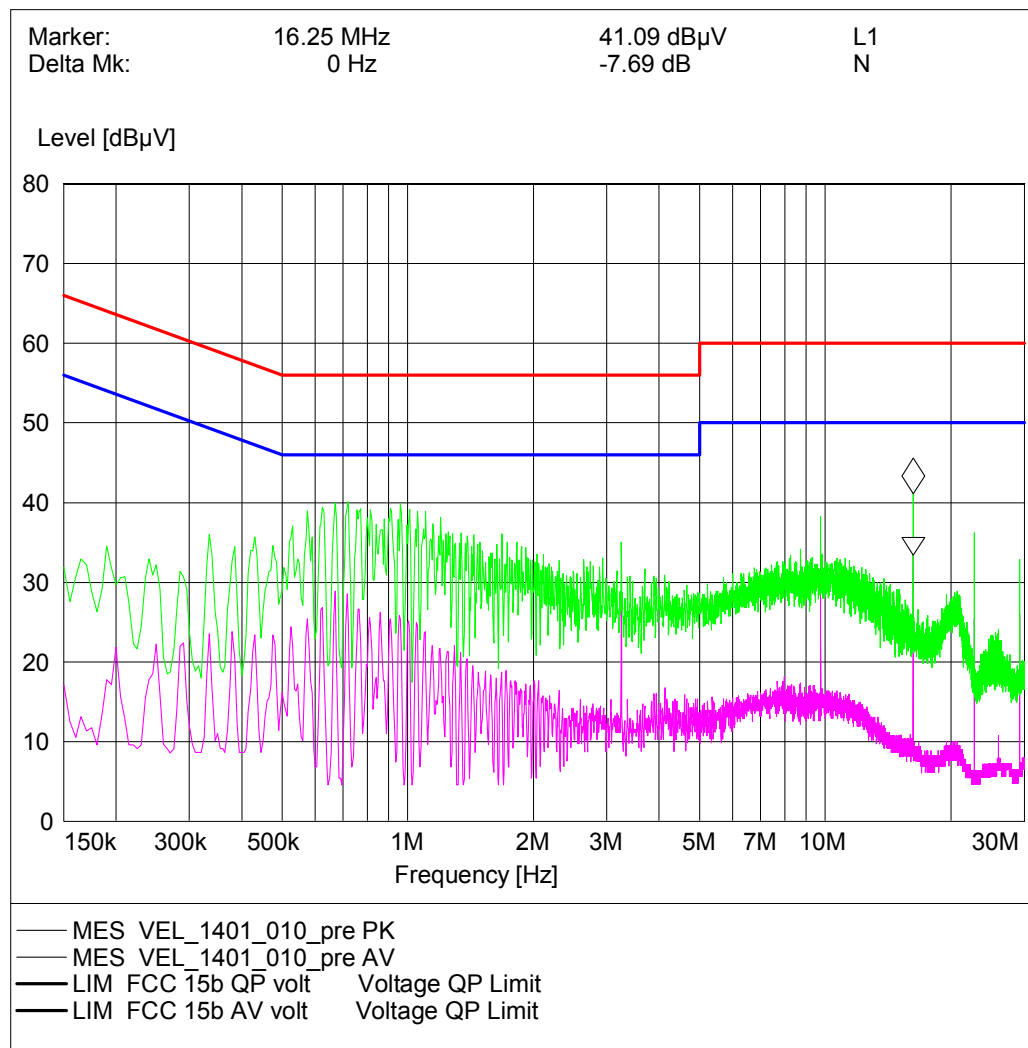
AC MAINS CONDUCTED

Diagram 1.01

EUT: (DE1097000ab01)
Manufacturer: Velolock Germany GmbH
Operating Condition: BT LE TX on mid CH; GSM 1900 TCH: 661; charging
Test Site: 7 layers Ratingen
Operator: URO
Test Specification: ANSI C63.4/10; FCC 15.107 / 15.207
Comment: 120 V / 60 Hz; AC/DC Adapter (US-Charger)
Start of Test: 25.08.2015 / 21:48:24

SCAN TABLE: "FCC Voltage"

Short Description:			FCC Voltage				
Start	Stop	Step	Detector	Meas. Time	IF Bandw.	Transducer	
Frequency	Frequency	Width					
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak	20.0 ms	9 kHz	ESH3-Z5	
			Average				

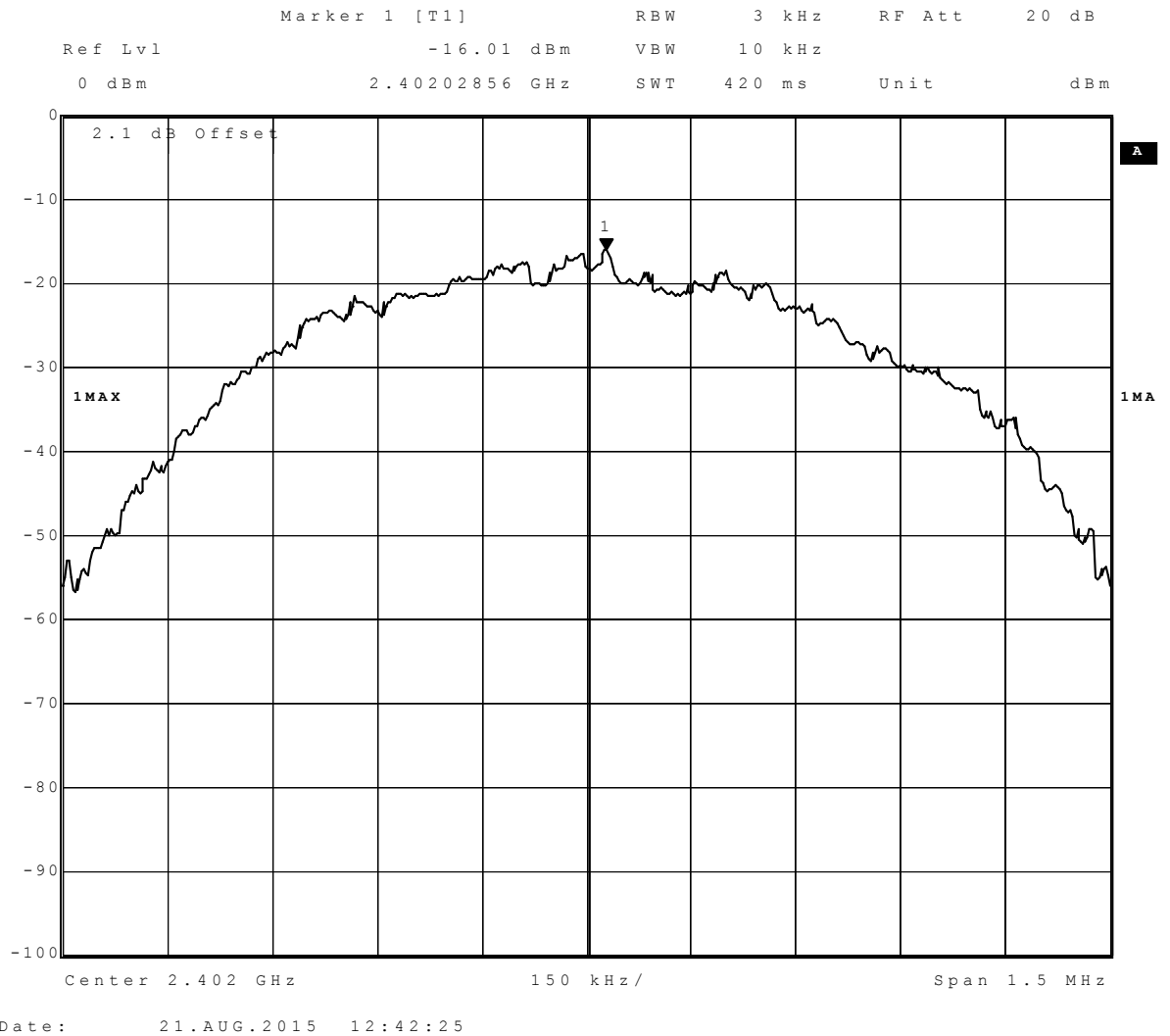


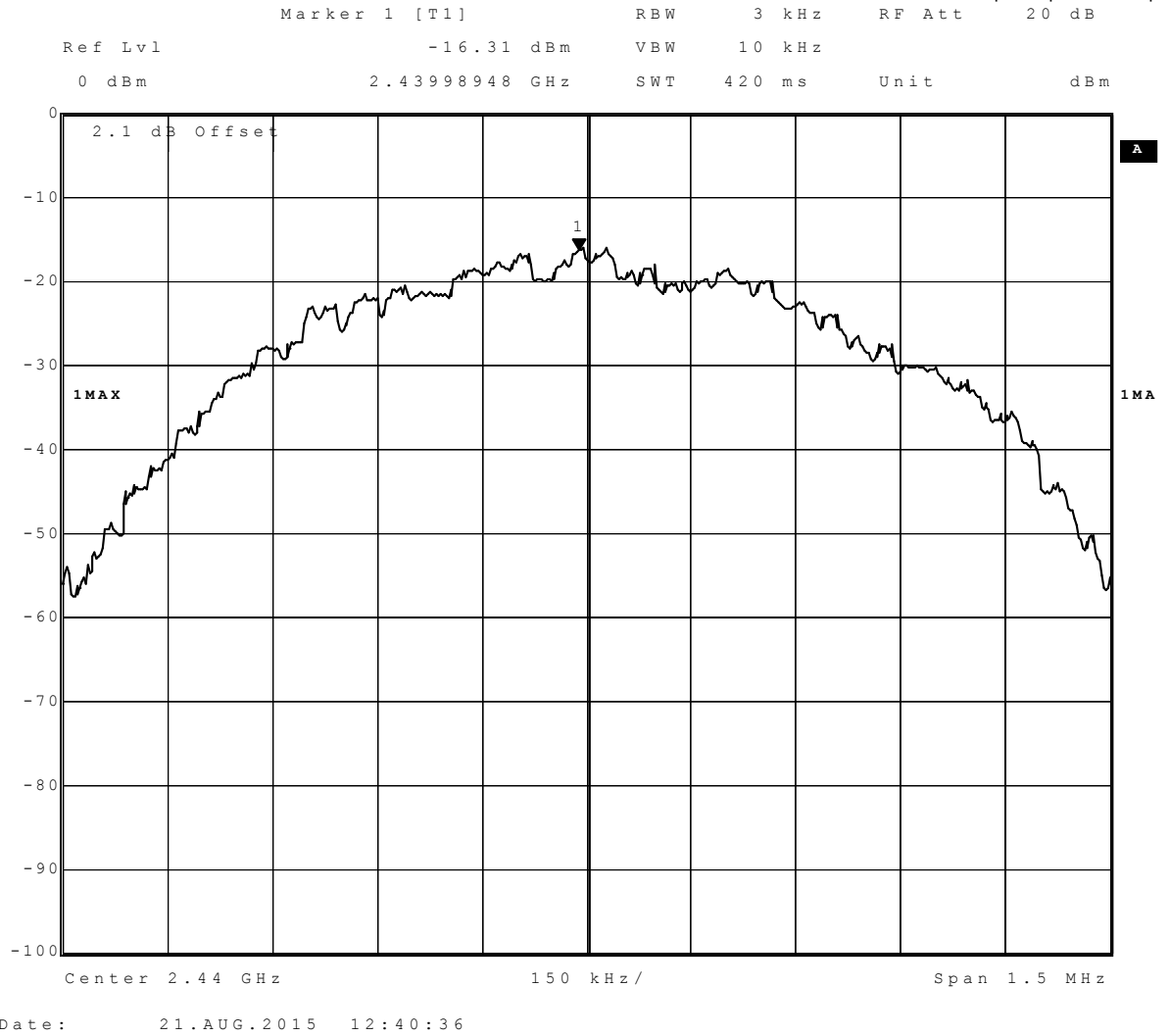
3.5.2 15c.10 Power density §15.247 (e)

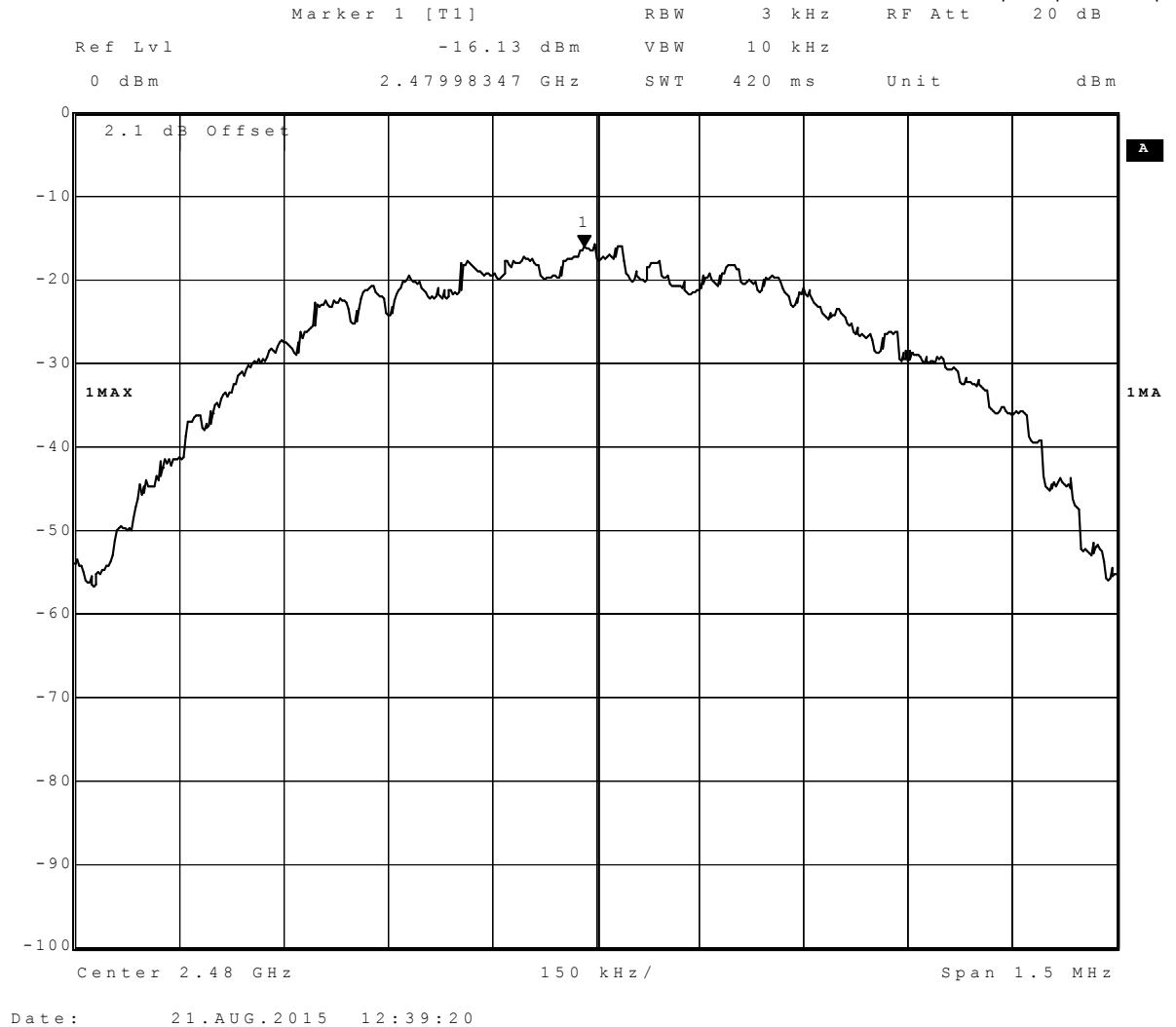
Test: 15c.10; Frequency = Low/Mid/High

<i>Result:</i>	Passed
<i>Setup No.:</i>	S01_AA01
<i>Date of Test:</i>	2015/09/04 8:34
<i>Body:</i>	FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
<i>Test Specification:</i>	FCC part 2 and 15

Detailed Results:







		Power Density			
		2402 MHz	2426 MHz	2440 MHz	2480 MHz
Modulation	Conditions	Power Density (dBm)	Power Density (dBm)	Power Density (dBm)	Power Density (dBm)
GFSK	TN, VN	-16.01	XXX	-16.31	-16.13

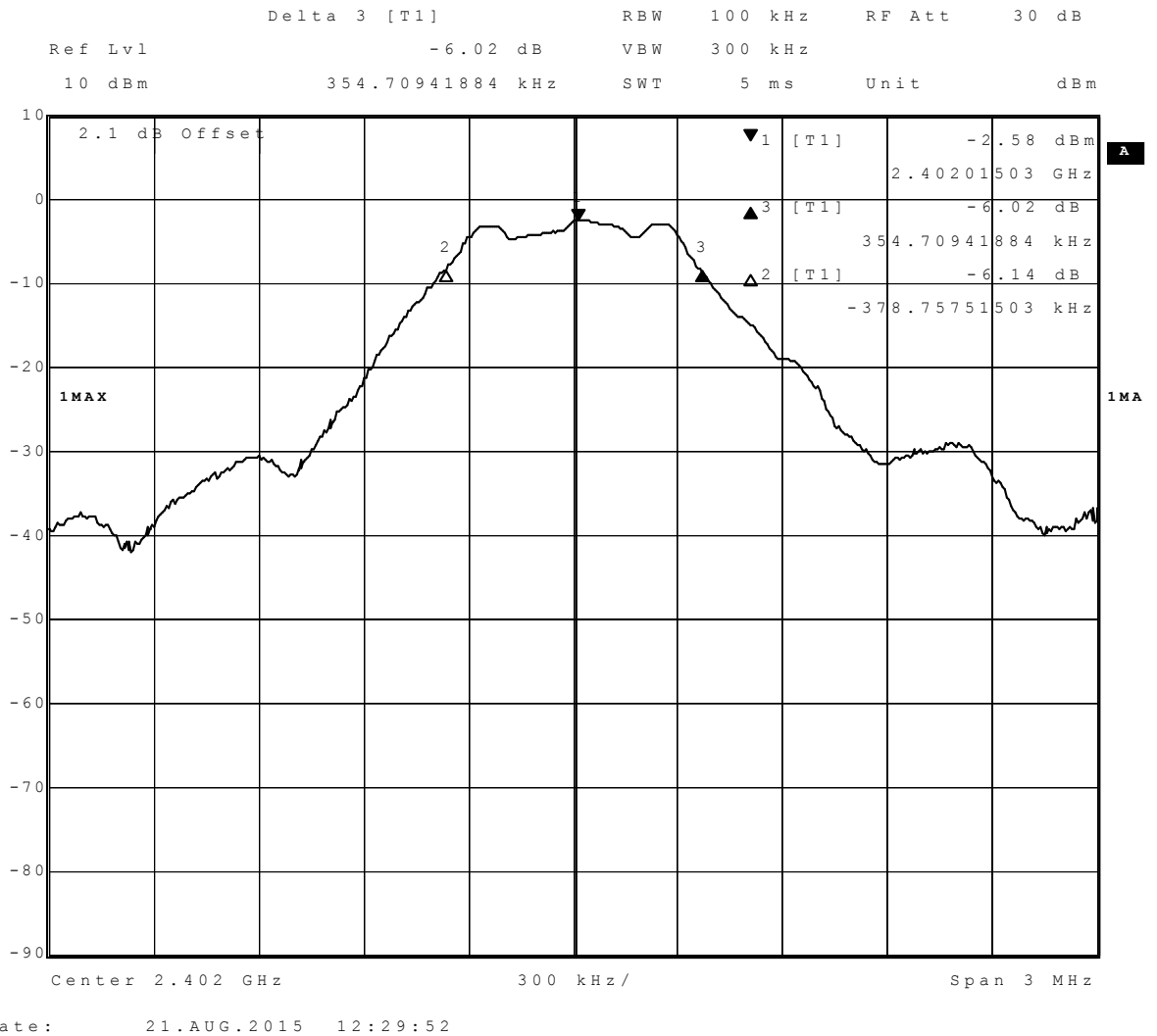
Maximum Power Density	-16.01	dBm
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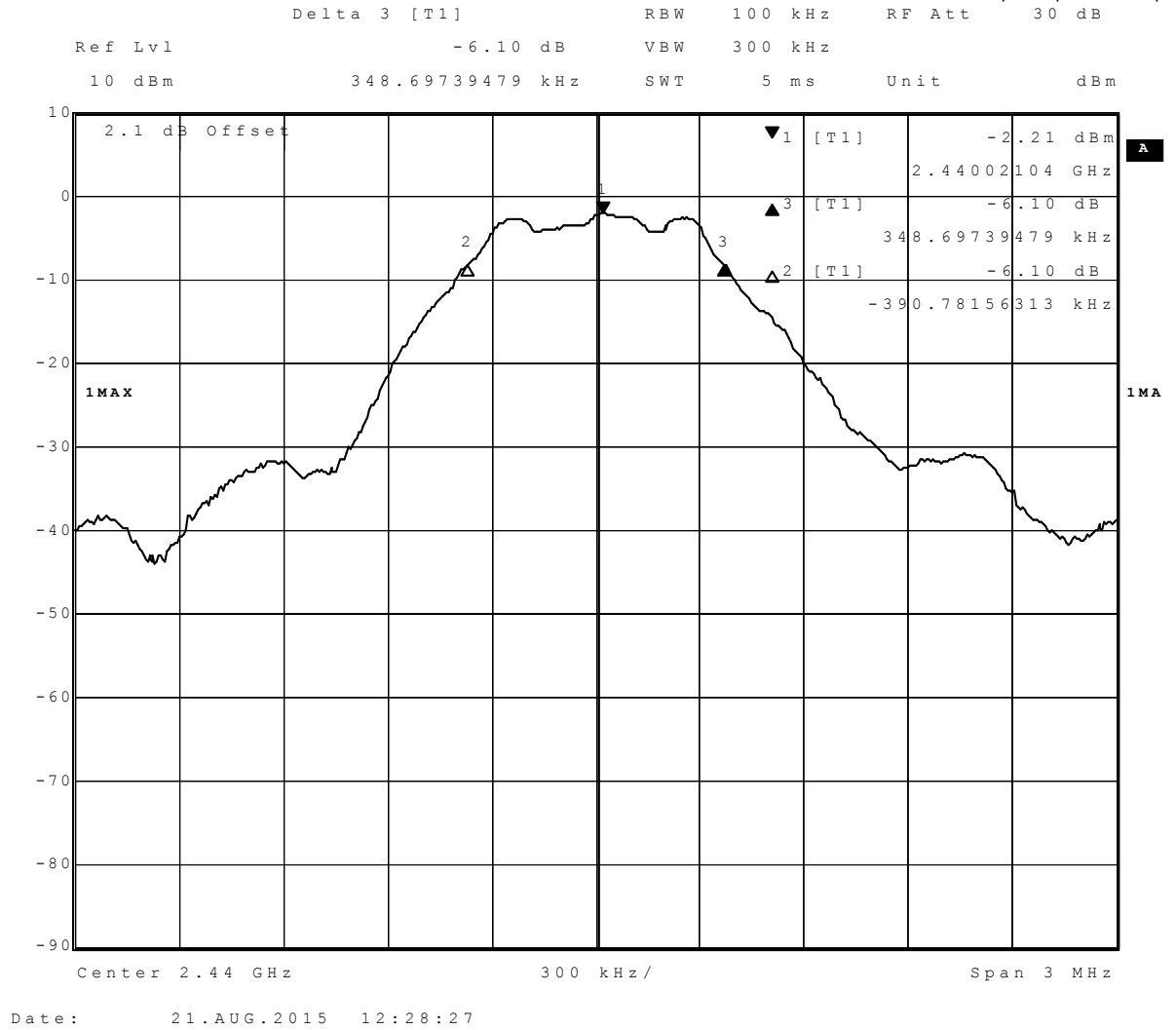
3.5.3 15c.11 6dB Bandwidth §15.247 (a) (2)

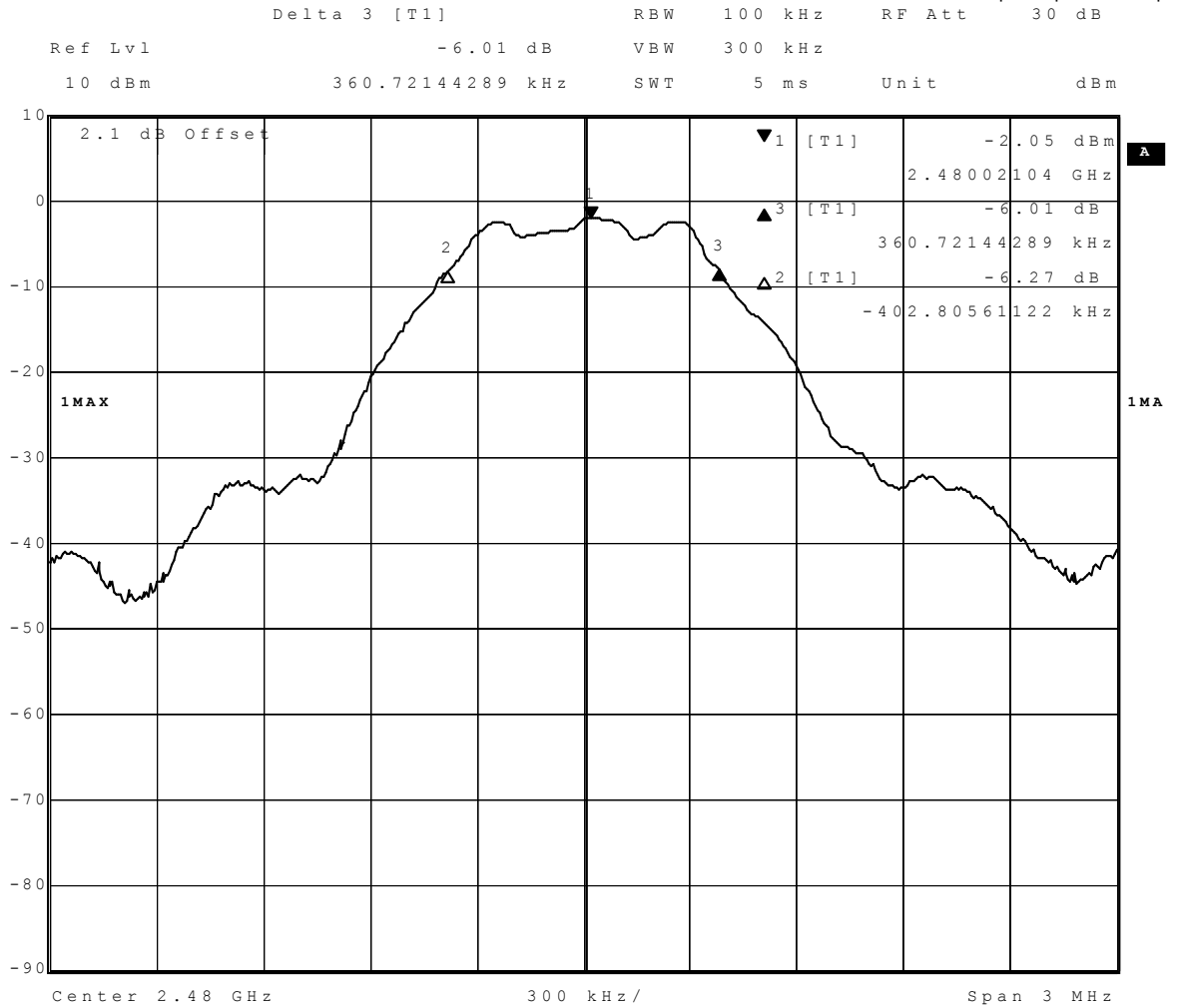
Test: 15c.11; Frequency = Low/Mid/High

<i>Result:</i>	Passed
<i>Setup No.:</i>	S01_AA01
<i>Date of Test:</i>	2015/09/04 8:34
<i>Body:</i>	FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
<i>Test Specification:</i>	FCC part 2 and 15

Detailed Results:







Date: 21.AUG.2015 12:26:53

Modulation	Frequency	6dB Bandwidth KHz
GFSK	2402 MHz	733.467
	2426 MHz	
	2440 MHz	739.479
	2480 MHz	763.527

3.5.4 15c.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209

Test: 15c.2 Spurious radiated emissions, highest channel, BT

Result: Passed

Setup No.: S01_AB01

Date of Test: 2015/08/26 12:52

Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209) CH 39

Frequency range 9 kHz - 1 GHz

Ant. Polar.	Limit QPK [dBµV]	Frequency [MHz]	Corrected value QPK [dBµV]	Margin QPK [dB]	Result
Ver + Hor					Passed

Frequency range 1 GHz - 25 GHz

Ant. Polar.	Limit PK [dBµV]	Limit AV [dBµV]	Frequency [MHz]	Corrected value PK [dBµV]	Corrected value AV [dBµV]	Margin PK [dB]	Margin AV [dB]	Result
Ver + Hor	74	54	4960	54.04	51.65	19.96	2.35	Passed

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Test: 15c.2 Spurious radiated emissions, lowest channel, BT

Result: Passed

Setup No.: S01_AC01

Date of Test: 2015/09/03 17:21

Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209) CH 0

Frequency range 9 kHz - 1 GHz

Ant. Polar.	Limit QPK [dBµV]	Frequency [MHz]	Corrected value QPK [dBµV]	Margin QPK [dB]	Result
Ver + Hor					Passed

Frequency range 1 GHz - 25 GHz

Ant. Polar.	Limit PK [dBµV]	Limit AV [dBµV]	Frequency [MHz]	Corrected value PK [dBµV]	Corrected value AV [dBµV]	Margin PK [dB]	Margin AV [dB]	Result
Ver + Hor	74	54	4804	52.63	49.53	21.37	4.47	Passed

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

Test: 15c.2 Spurious radiated emissions, mid channel, BT

Result: Passed

Setup No.: S01_AB01

Date of Test: 2015/08/26 12:51

Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209) CH 19

Frequency range 9 kHz - 1 GHz

Ant. Polar.	Limit QPK [dBμV]	Frequency [MHz]	Corrected value QPK [dBμV]	Margin QPK [dB]	Result
Ver + Hor					Passed

Frequency range 1 GHz - 25 GHz

Ant. Polar.	Limit PK [dBμV]	Limit AV [dBμV]	Frequency [MHz]	Corrected value PK [dBμV]	Corrected value AV [dBμV]	Margin PK [dB]	Margin AV [dB]	Result
Ver + Hor	74	54	4880	55.48	53.78	18.52	0.22	Passed

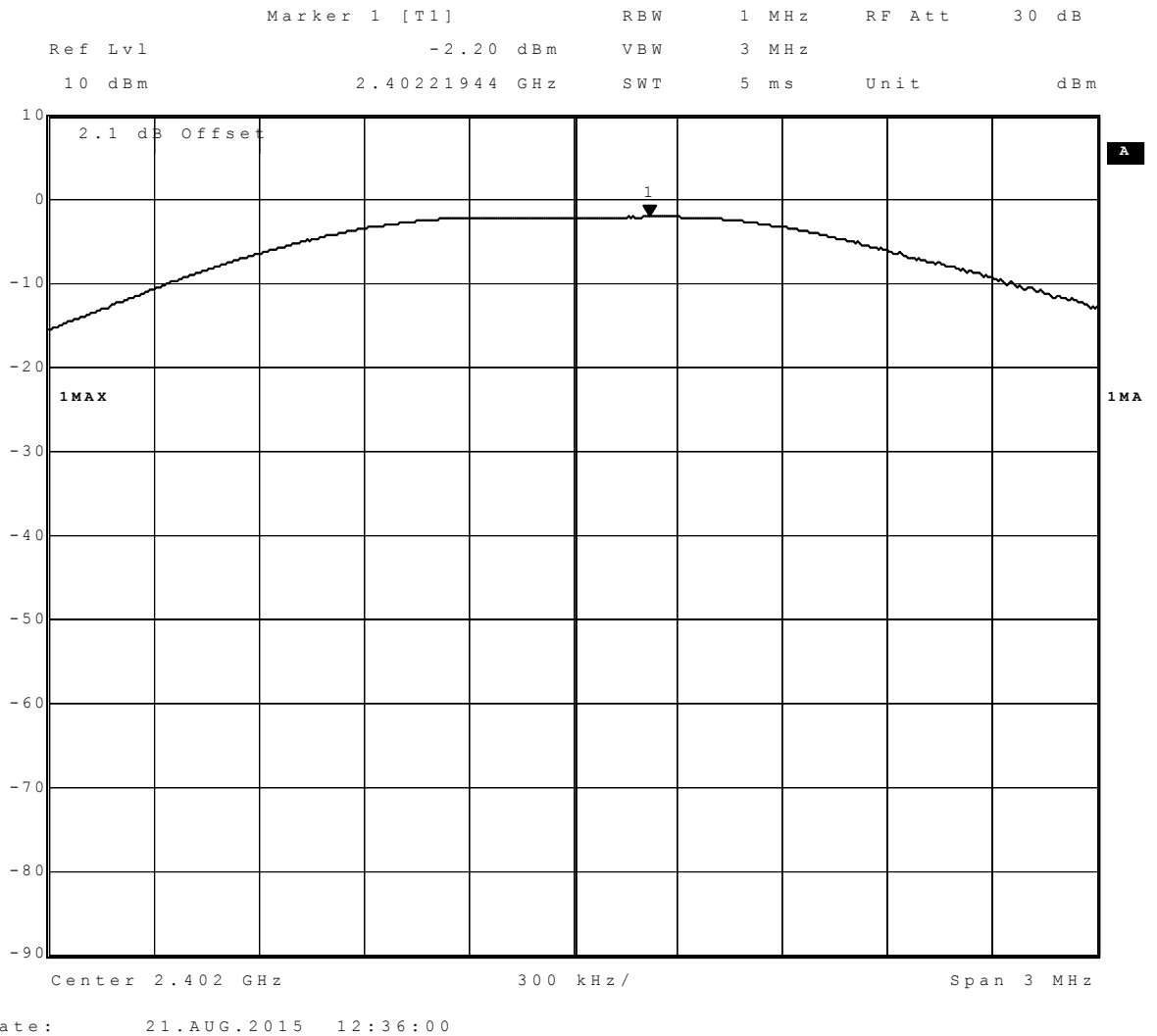
Remark: No (further) spurious emissions in the range 20 dB below the limit found.

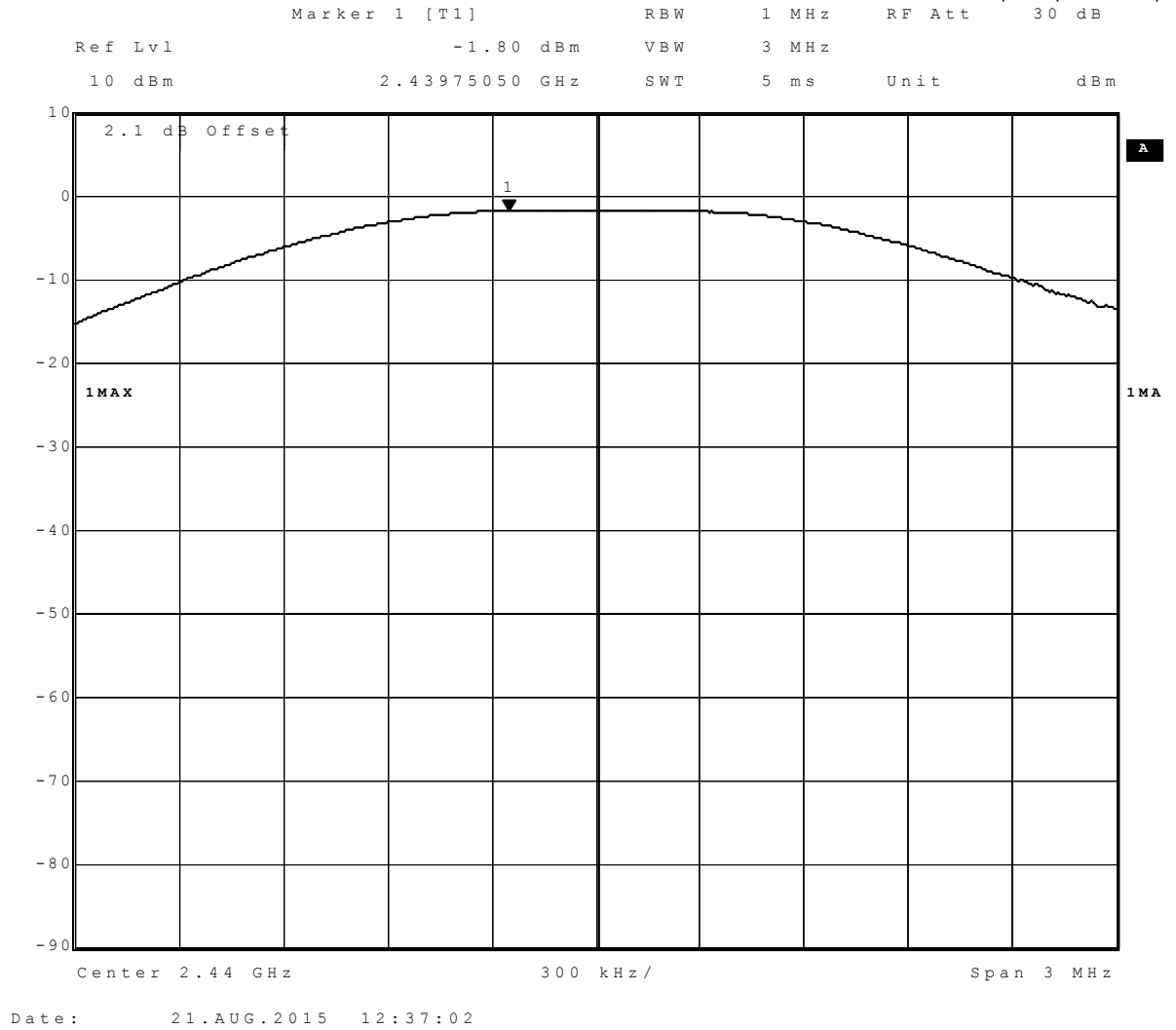
3.5.5 15c.4 Peak power output §15.247 (b) (1)

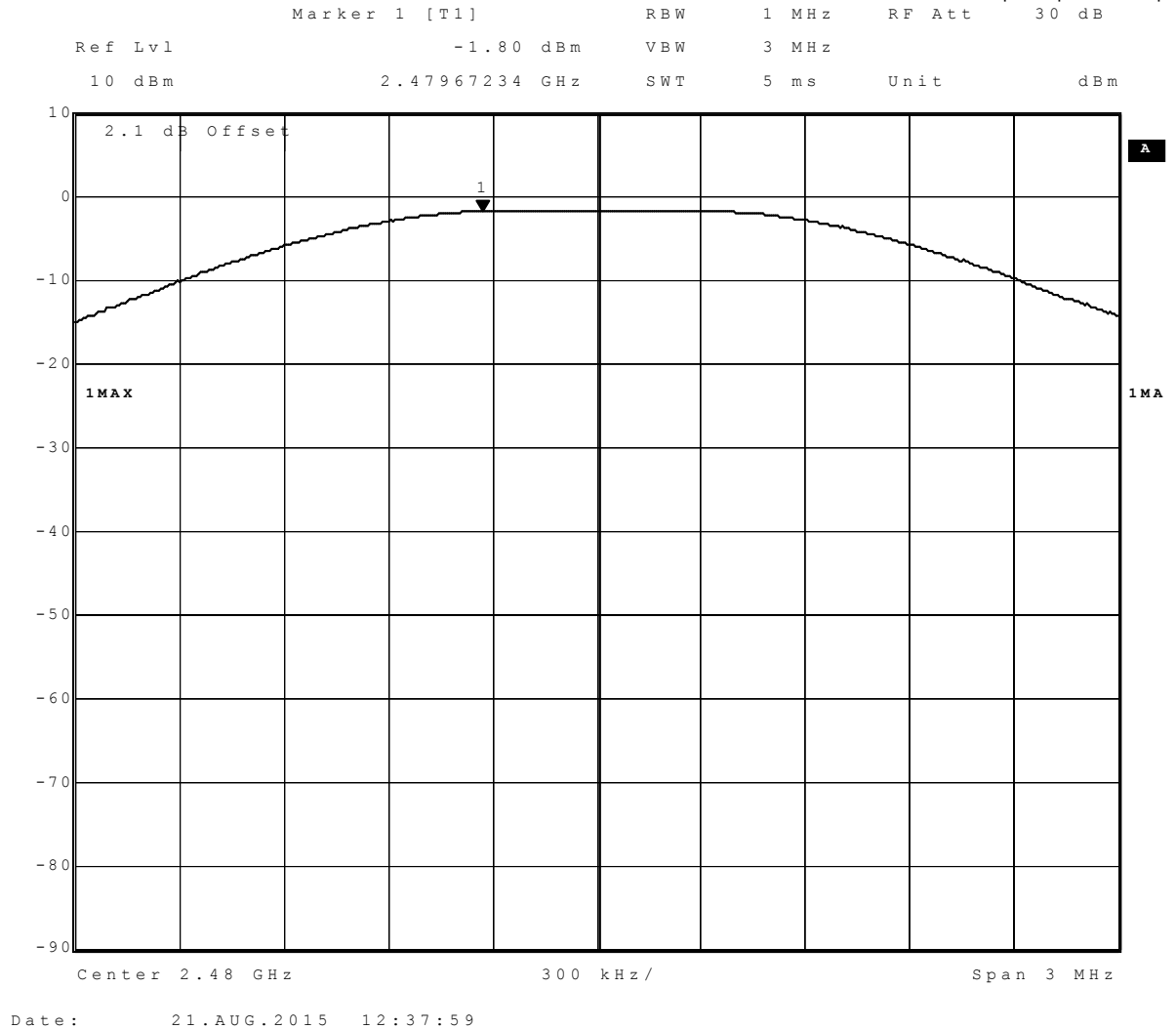
Test: 15c.4; Peak power output Summary

Result:	Passed
Setup No.:	S01_AA01
Date of Test:	2015/09/04 8:32
Body:	FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
Test Specification:	FCC part 2 and 15

Detailed Results:







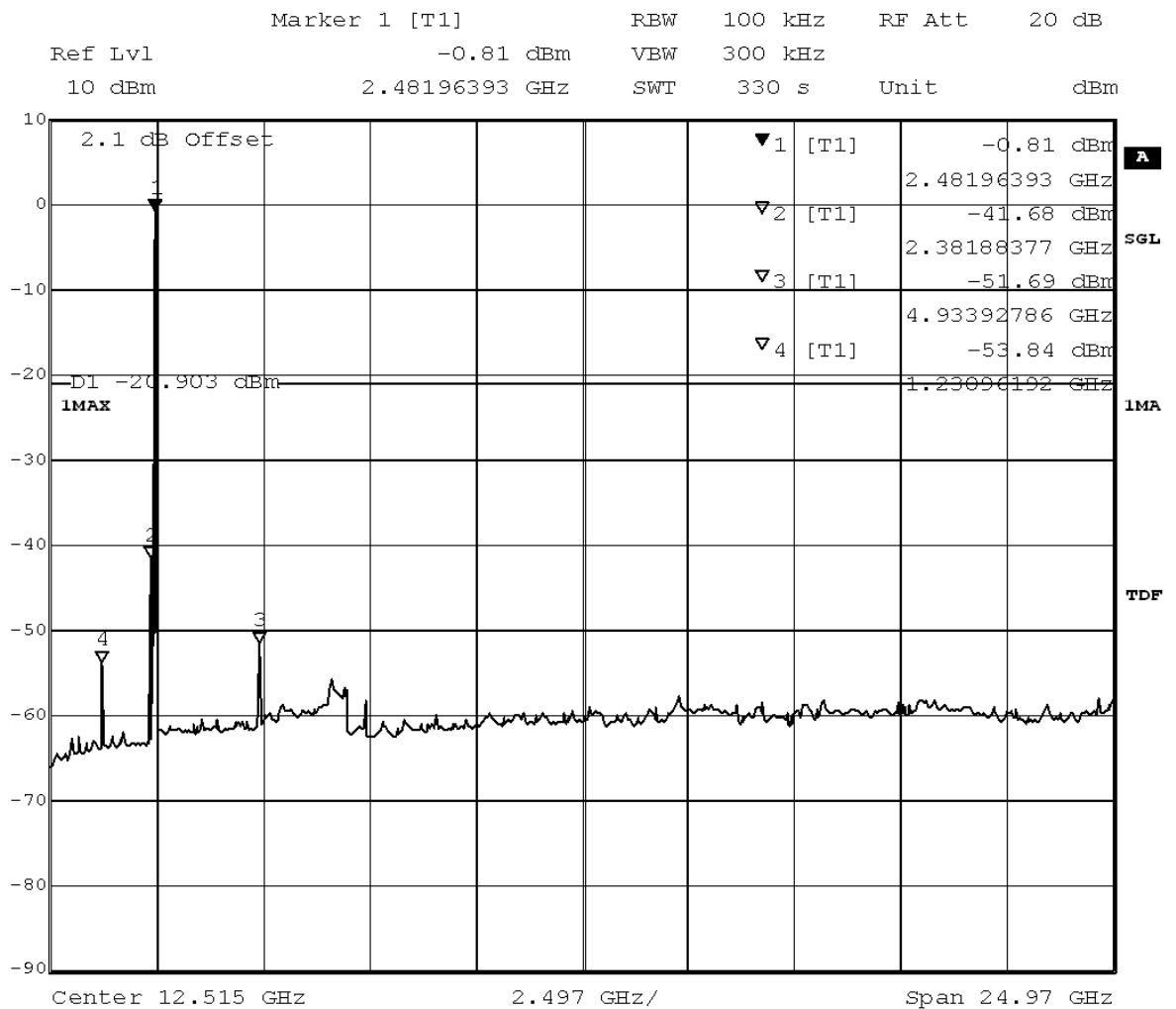
		Transmitter Power (including antenna gain)							
		2402 MHz		2440 MHz		2426 MHz		2480 MHz	
Modulation	Conditions	Output Power (dBm)	Margin to Limit (dB)	Output Power (dBm)	Margin to Limit (dB)	Output Power (dBm)	Margin to Limit (dB)	Output Power (dBm)	Margin to Limit (dB)
GFSK Bluetooth Low Energy	TN, VN	-2.2	6.2	-1.8	5.8	XX	XX	-1.8	5.8

3.5.6 15c.5 Spurious RF conducted emissions §15.247 (d)

Test: 15c.5 Spurious RF conducted emissions, highest channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/09/04 8:37
Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

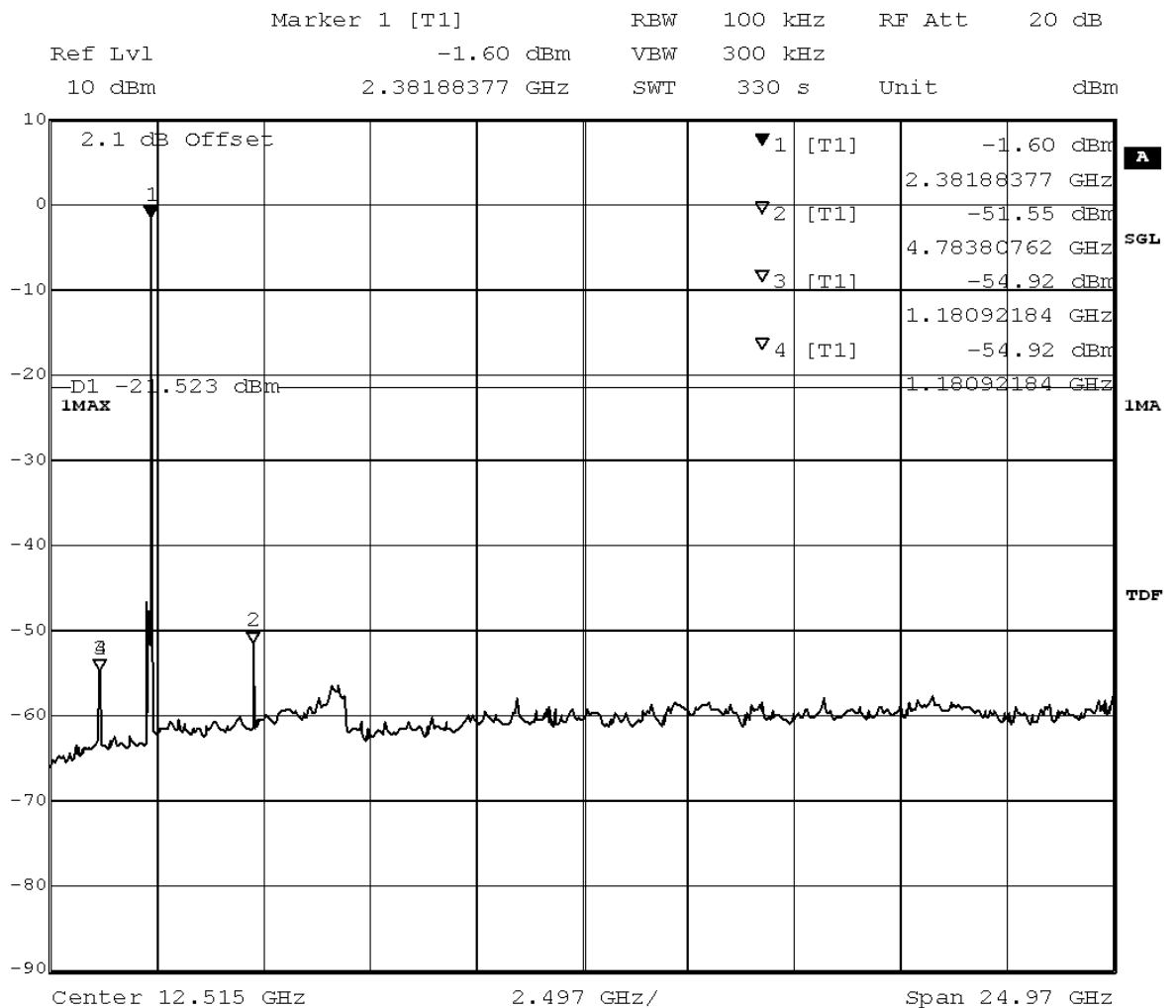


Title: spurious emissions
Comment A: CH T:2480 MHz
Date: 21.AUG.2015 12:21:35

Test: 15c.5 Spurious RF conducted emissions, lowest channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/09/04 8:37
Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

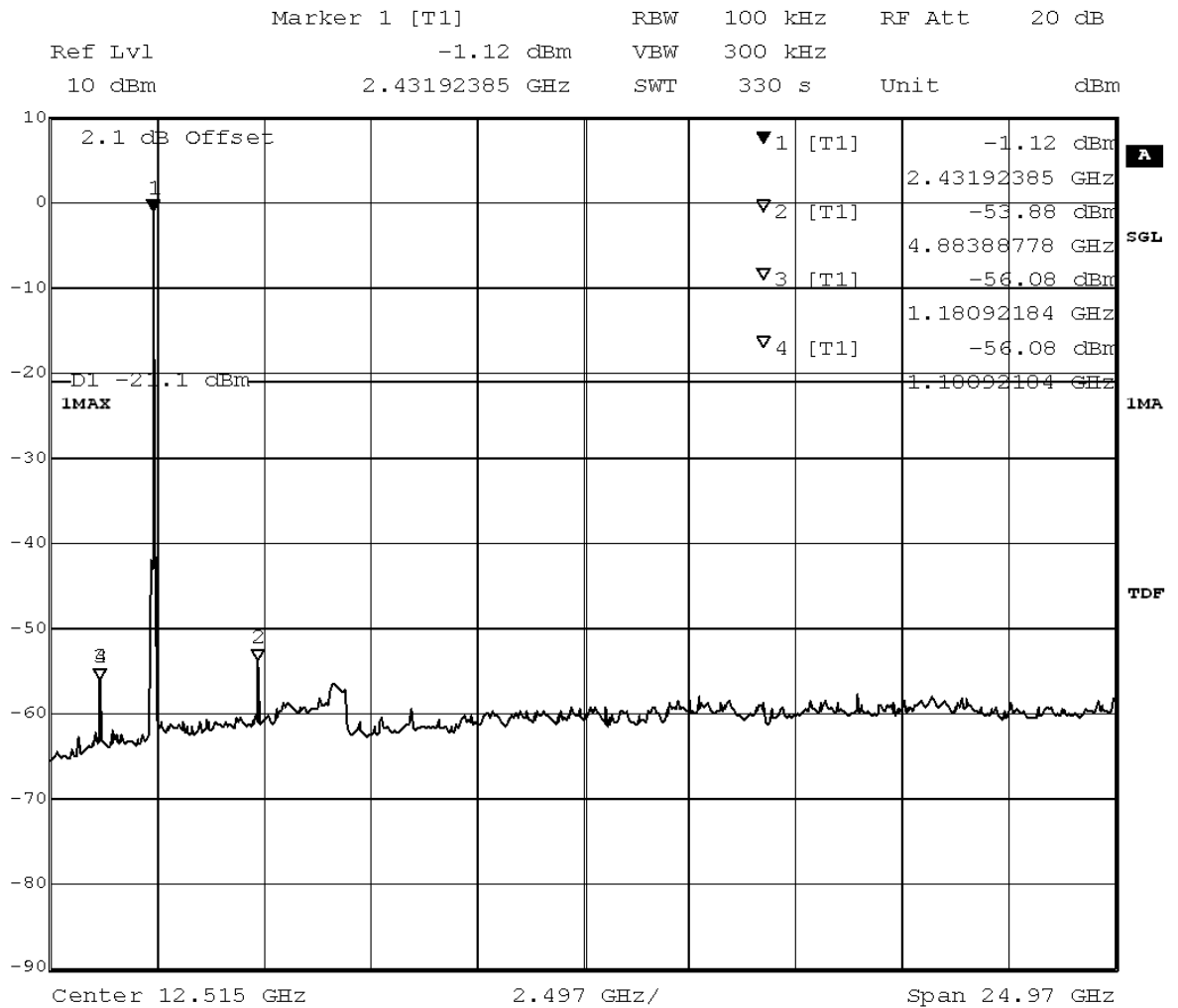


Title: spurious emissions
Comment A: CH B: 2402 MHz
Date: 21.AUG.2015 11:13:40

Test: 15c.5 Spurious RF conducted emissions, mid channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/09/04 8:36
Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:



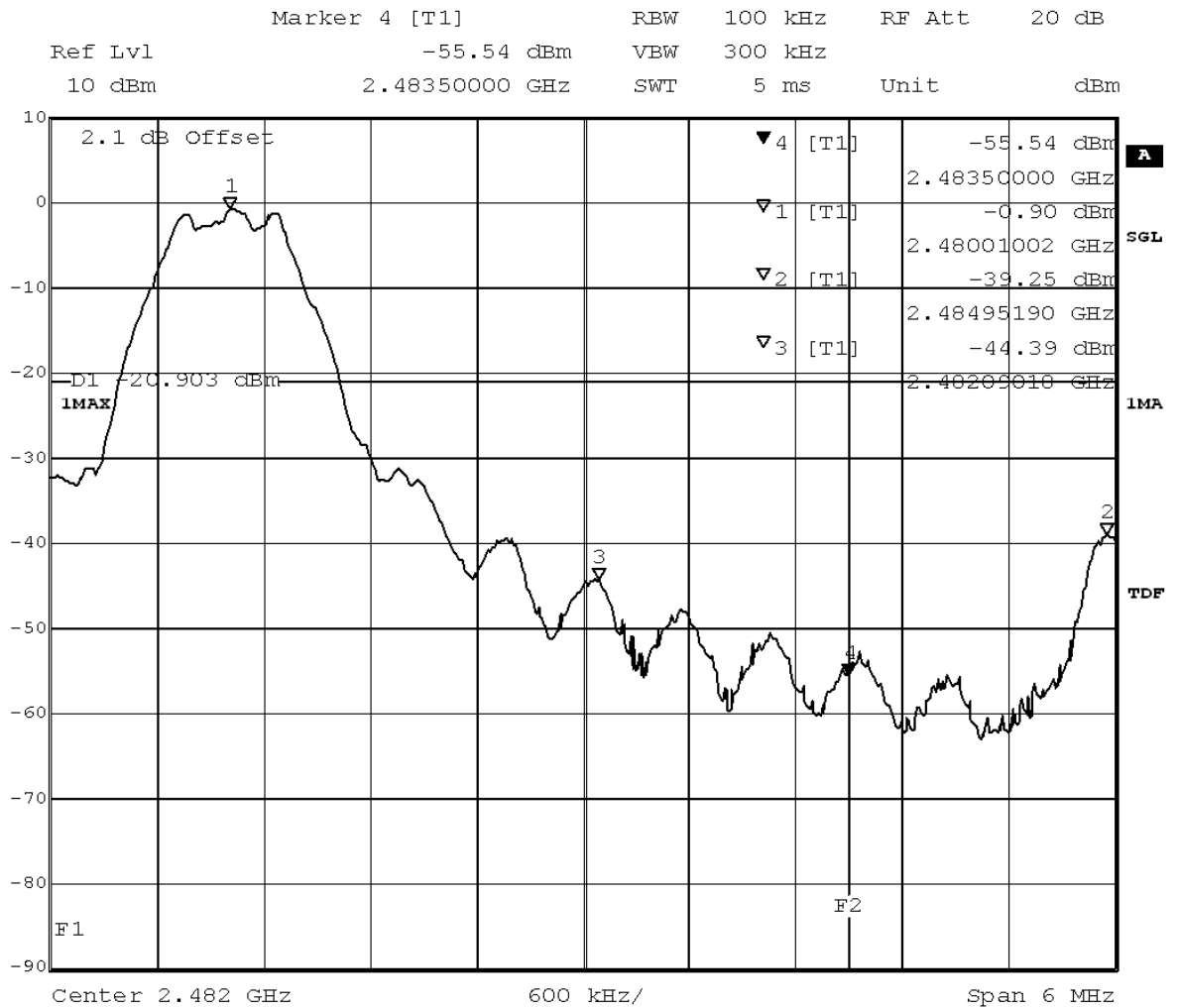
Title: spurious emissions
Comment A: CH M2: 2440 MHz
Date: 21.AUG.2015 11:26:36

3.5.7 15c.6 Band edge compliance §15.247 (d)

Test: 15c.6 Band edge compliance, highest channel, BT

<i>Result:</i>	Passed
<i>Setup No.:</i>	S01_AA01
<i>Date of Test:</i>	2015/09/04 8:36
<i>Body:</i>	FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
<i>Test Specification:</i>	FCC part 2 and 15

Detailed Results:



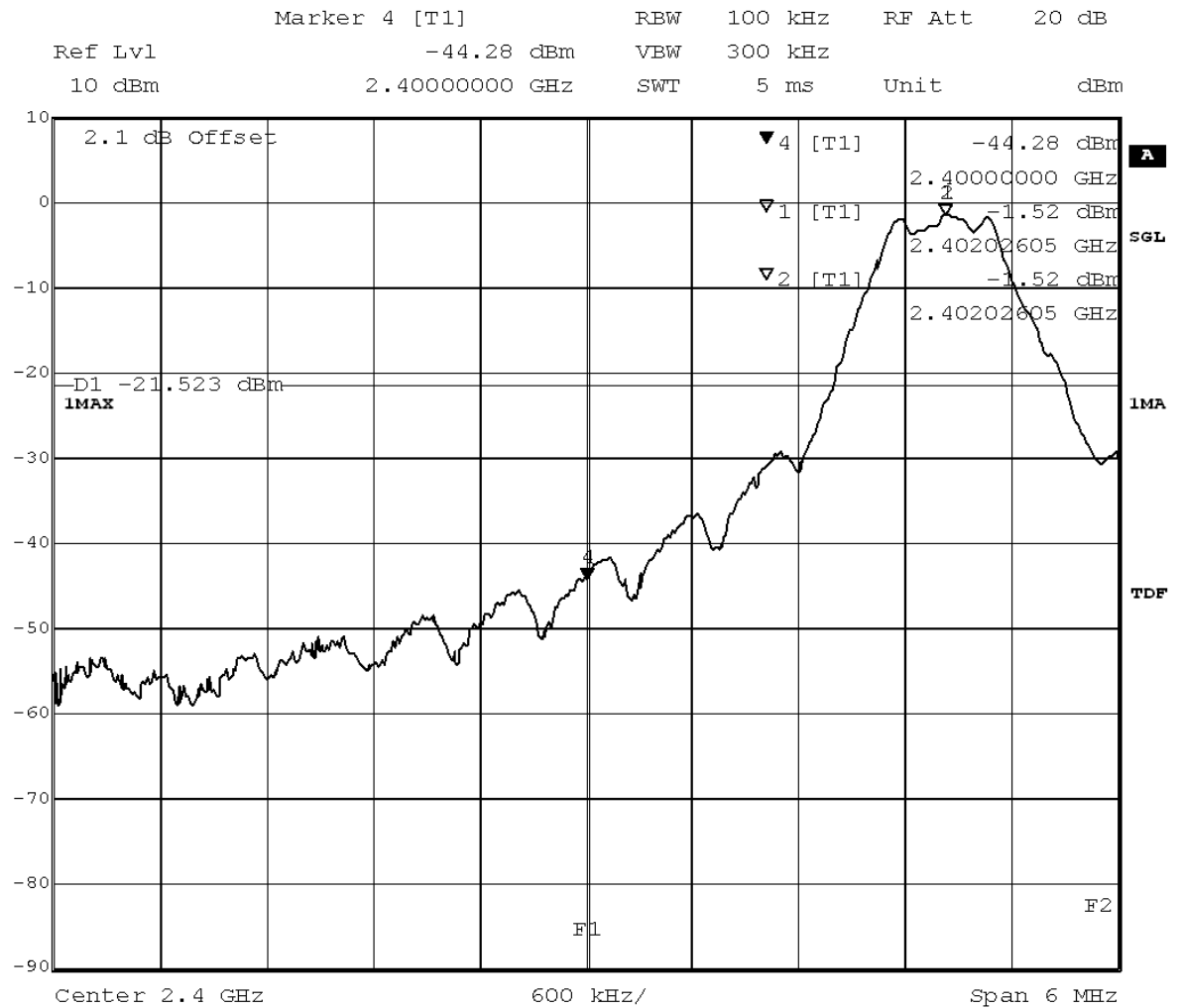
Title: Band Edge Compliance
Comment A: CH T:2480 MHz
Date: 21.AUG.2015 12:09:39

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2484	-55.54	-0.90	-20.90	34.63

Test: 15c.6 Band edge compliance, lowest channel, BT

Result: Passed
Setup No.: S01_AA01
Date of Test: 2015/09/04 8:35
Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:



Title: Band Edge Compliance
Comment A: CH B: 2402 MHz
Date: 21.AUG.2015 11:01:44

Frequency MHz	Measured value dBm	Reference value dBm	Limit dBm	Margin to limit dB
2400	-44.28	-1.52	-21.52	22.76

Test: 15c.6; Frequency = 2480, Mode = Bluetooth Low Energy

Result: Passed

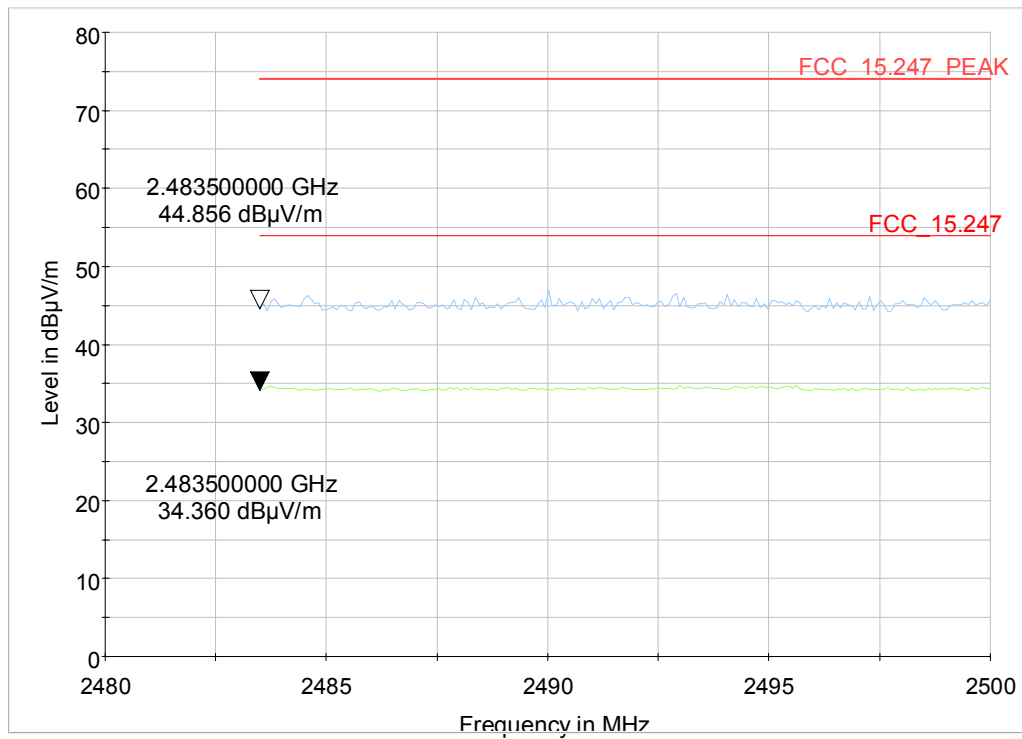
Setup No.: S01_AB01

Date of Test: 2015/08/26 11:55

Body: FCC47CFRChIPART15c231RADIO FREQUENCY DEVICES

Test Specification: FCC part 2 and 15

Detailed Results:



4 Test Equipment Details

4.1 List of Used Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	Lab 2		
Manufacturer:	Frankonia		
Description:	Anechoic Chamber for radiated testing		
Type:	10.58x6.38x6.00 m ³		
	<i>Calibration Details</i>	<i>Last Execution</i>	<i>Next Execution</i>
	NSA (FCC)	2014/01/09	2017/01/09

Single Devices for Anechoic Chamber

<i>Single Device Name</i>	<i>Type</i>	<i>Serial Number</i>	<i>Manufacturer</i>	
Air compressor	none	-	Atlas Copco	
Anechoic Chamber	10.58 x 6.38 x 6.00 m ³	none	Frankonia	
	<i>Calibration Details</i>		<i>Last Execution</i>	<i>Next Execution</i>
	FCC listing 96716 3m Part15/18		2014/01/09	2017/01/08
Controller Maturo	MCU	961208	Maturo GmbH	
EMC camera	CE-CAM/1	-	CE-SYS	
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi	
Filter ISDN	B84312-C110-E1		Siemens&Matsushita	
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita	

Test Equipment Auxiliary Equipment for Conducted emissions

Lab ID: **Lab 1**
Manufacturer: Rohde & Schwarz GmbH & Co.KG
Description: EMI Conducted Auxiliary Equipment

Single Devices for Auxiliary Equipment for Conducted emissions

Single Device Name	Type	Serial Number	Manufacturer		
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber&Suhner		
Impedance Stabilization Network	ISN T800	36159	Teseq GmbH		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard Calibration			2014/02/06	2016/02/28
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ENY41	100002	Rohde & Schwarz GmbH & Co. KG		
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ST08	36292	Teseq GmbH		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2014/01/10	2016/01/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN T8-Cat6	32187	Teseq GmbH		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard Calibration			2014/01/08	2016/01/31
One-Line V-Network	ESH 3-Z6	100489	Rohde & Schwarz GmbH & Co. KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	standard calibration			2014/06/18	2017/11/30
One-Line V-Network	ESH 3-Z6	100570	Rohde & Schwarz GmbH & Co. KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard Calibration			2013/11/25	2016/11/24
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	DAkKS Calibration			2015/03/30	2017/03/31
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	DAkks Calibration			2015/03/30	2017/03/31

Test Equipment Auxiliary Equipment for Radiated emissions

Lab 1D:	Lab 2
<i>Description:</i>	Equipment for emission measurements
<i>Serial Number:</i>	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

<i>Single Device Name</i>	<i>Type</i>	<i>Serial Number</i>	<i>Manufacturer</i>		
Antenna mast	AM 4.0	AM4.0/180/11920 513	Maturo GmbH		
Biconical Broadband Antenna	SBA 9119	9119-005	Schwarzbeck Mess- Elektronik OHG		
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck Mess- Elektronik OHG		
Broadband Amplifier 1 GHz - 4 GHz	AFS4-01000400-1Q-10P-4	-	Miteq		
Broadband Amplifier 18 GHz - 26 GHz	JS4-18002600-32-5P	849785	Miteq		
Broadband Amplifier 30 MHz - 18 GHz	JS4-00101800-35-5P	896037	Miteq		
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01- 2+W38.01-2	Kabel Kusch		
Cable "ESI to Horn Antenna"	SucoFlex	W18.02- 2+W38.02-2	HUBER+SUHNER		
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG		
<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>	
Standard Calibration			2015/06/23	2018/06/22	
Double-ridged horn	HF 907	102444	Rohde & Schwarz GmbH & Co. KG		
<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>	
Standard Calibration			2015/05/11	2018/05/10	
Double-ridged horn- duplicated 2015-07- 15 10:47:55	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG		
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic		
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic		
High Pass Filter	5HC3500/18000-1.2-KK	200035008	Trilithic		
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright		
Horn Antenna Schwarzbeck 15-26.5 GHz BBHA 9170	BBHA 9170	BBHA9170262	Schwarzbeck Mess- Elektronik OHG		
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG		
<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>	
Standard Calibration			2012/12/18	2015/12/17	
Log.-per. Antenna (upgraded)	HL 562 Ultralog new biconicals	830547/003	Rohde & Schwarz GmbH & Co. KG		
<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>	
Standard Calibration			2015/06/30	2018/06/29	
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG		
<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>	
DKD Calibration			2014/11/27	2017/11/27	

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	Type	Serial Number	Manufacturer
Standard Gain / Pyramidal Horn Antenna 26.5 GHz	3160-09	00083069	EMCO Elektronik GmbH
Standard Gain / Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5- 10kg/024/379070 9	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	Lab 2
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	Type	Serial Number	Manufacturer
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.
<i>Calibration Details</i>			<i>Last Execution</i> <i>Next Execution</i>
Customized calibration			2013/12/04 2015/12/03
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorwerke GmbH
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright
Signal Analyzer	FSV30	103005	Rohde & Schwarz GmbH & Co. KG
<i>Calibration Details</i>			<i>Last Execution</i> <i>Next Execution</i>
Standard			2014/02/10 2016/02/09
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG
<i>Calibration Details</i>			<i>Last Execution</i> <i>Next Execution</i>
DKD calibration			2015/06/23 2018/06/22
Spectrum Analyser	FSU26	200418	Rohde & Schwarz GmbH & Co.KG
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID: Lab 1, Lab 2
Description: Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	Type	Serial Number	Manufacturer	
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG	
	<i>Calibration Details</i>		<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration		2014/01/27	2016/01/26
Digital Radio Communication Tester	CMD 55	831050/020	Rohde & Schwarz GmbH & Co. KG	
	<i>Calibration Details</i>		<i>Last Execution</i>	<i>Next Execution</i>
	DKD calibration		2014/12/02	2017/12/01
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG	
	<i>HW/SW Status</i>		<i>Date of Start</i>	<i>Date of End</i>
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16	
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG	
	<i>Calibration Details</i>		<i>Last Execution</i>	<i>Next Execution</i>
	DKD calibration		2014/12/03	2017/12/02
	<i>HW/SW Status</i>		<i>Date of Start</i>	<i>Date of End</i>
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 --- SW: K62, K69		2007/01/02	
Vector Signal Generator	SMU200A	100912	Rohde & Schwarz GmbH & Co. KG	
			2008/11/03	

Test Equipment Emission measurement devices

Lab ID: Lab 1, Lab 2
Description: Equipment for emission measurements
Serial Number: see single devices

Single Devices for Emission measurement devices

Single Device Name	Type	Serial Number	Manufacturer		
EMI Receiver / Spectrum Analyser	ESR 7	101424	Rohde & Schwarz		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Initial Factory Calibration			2014/11/13	2016/11/12
Personal Computer	Dell	30304832059	Dell		
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2015/05/11	2016/05/10
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2015/05/11	2016/05/10
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard Calibration			2014/06/24	2017/06/23
Spectrum Analyser	FSW 43	103779	Rohde & Schwarz		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Initial Factory Calibration			2014/11/17	2016/11/16
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard Calibration			2014/01/07	2016/01/31
	<i>HW/SW Status</i>			<i>Date of Start</i>	<i>Date of End</i>
	Firmware-Update 4.34.4 from 3.45 during calibration			2009/12/03	

Test Equipment Multimeter 03

Lab ID: Lab 2
Description: Fluke 177
Serial Number: 86670383

Single Devices for Multimeter 03

Single Device Name	Type	Serial Number	Manufacturer		
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Customized calibration			2013/12/04	2015/12/03

Test Equipment Multimeter 12

Lab ID: Lab 3
Description: Ex-Tech 520
Serial Number: 05157876

Single Devices for Multimeter 12

Single Device Name	Type	Serial Number	Manufacturer		
Digital Multimeter 12 (Multimeter)	EX520	05157876	Extech Instruments Corp.		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Customized calibration			2013/12/04	2015/12/03

Test Equipment Regulatory Bluetooth RF Test Solution

Lab ID: Lab 3
Description: Regulatory Bluetooth RF Tests
Type: Bluetooth RF
Serial Number: 001

Single Devices for Regulatory Bluetooth RF Test Solution

Single Device Name	Type	Serial Number	Manufacturer		
ADU 200 Relay Box 7	Relay Box	A04380	Ontrak Control Systems Inc.		
Bluetooth Signalling Unit CBT	CBT	100302	Rohde & Schwarz GmbH & Co.KG		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2014/08/29	2015/08/28
	Standard Calibration			2015/08/20	2016/08/19
Power Meter NRVD	NRVD	832025/059			
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2014/08/29	2015/08/28
	Standard Calibration			2015/08/19	2016/08/18
Power Sensor NRV Z1 A	PROBE	832279/013			
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2014/08/28	2015/08/27
	Standard Calibration			2015/08/18	2016/08/17
Power Supply	NGSM 32/10	2725			
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2015/06/22	2016/06/21
Rubidium Frequency Normal MFS	Datum MFS	002	Datum GmbH		
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2014/08/29	2015/08/28
	Standard Calibration			2015/08/25	2016/08/24
Signal Analyser FSIQ26	1119.6001.26	832695/007	Rohde & Schwarz GmbH & Co.KG		
Vector Signal Generator SMIQ03B	SMIQ03B	832870/017			
	<i>Calibration Details</i>			<i>Last Execution</i>	<i>Next Execution</i>
	Standard calibration			2013/06/21	2016/06/20

Test Equipment Shielded Room 02

Lab ID: Lab 1
Manufacturer: Frankonia
Description: Shielded Room for conducted testing
Type: 12 qm
Serial Number: none

Test Equipment Shielded Room 07

Lab ID: Lab 3
Description: Shielded Room 4m x 6m

Test Equipment T/A Logger 13

Lab ID: Lab 1, Lab 2
Description: Lufft Opus10 TPR
Type: Opus10 TPR
Serial Number: 13936

Single Devices for T/A Logger 13

Single Device Name	Type	Serial Number	Manufacturer		
ThermoAirpressure Datalogger 13 (Environ)	Opus10 TPR (8253.00)	13936	Lufft Mess- und Regeltechnik GmbH		
	Calibration Details			Last Execution	Next Execution
	Customized calibration			2015/02/27	2017/02/26

Test Equipment T/H Logger 02

Lab ID: Lab 1
Description: Lufft Opus10
Serial Number: 7489

Single Devices for T/H Logger 02

Single Device Name	Type	Serial Number	Manufacturer		
ThermoHygro Datalogger 02 (Environ)	Opus10 THI (8152.00)	7489	Lufft Mess- und Regeltechnik GmbH		
	Calibration Details			Last Execution	Next Execution
	Customized calibration			2015/02/27	2017/02/26

Test Equipment T/H Logger 12

Lab ID: Lab 2
Description: Lufft Opus10
Serial Number: 12482

Single Devices for T/H Logger 12

Single Device Name	Type	Serial Number	Manufacturer		
ThermoHygro Datalogger 12 (Environ)	Opus10 THI (8152.00)	12482	Lufft Mess- und Regeltechnik GmbH		
	Calibration Details			Last Execution	Next Execution
	Customized calibration			2015/03/10	2017/03/09

Test Equipment T/H Logger 15

Lab ID: Lab 3
Description: Lufft Opus10
Serial Number: 13985

Single Devices for T/H Logger 15

Single Device Name	Type	Serial Number	Manufacturer
ThermoHygro Datalogger 15 (Environ)	Opus10 THI (8152.00)	13985	Lufft Mess- und Regeltechnik GmbH
<i>Calibration Details</i>		<i>Last Execution</i>	<i>Next Execution</i>
Customized calibration		2015/03/10	2017/03/09

Test Equipment Temperature Chamber 01

Lab ID: Lab 3
Manufacturer: see single devices
Description: Temperature Chamber KWP 120/70
Type: Weiss
Serial Number: see single devices

Single Devices for Temperature Chamber 01

Single Device Name	Type	Serial Number	Manufacturer
Temperature Chamber Weiss 01	KWP 120/70	59226012190010	Weiss Umwelttechnik GmbH
<i>Calibration Details</i>		<i>Last Execution</i>	<i>Next Execution</i>
Customized calibration		2014/03/12	2016/03/11

5 Annex

5.1 Additional Information for Report

Summary of Test Results

The EUT complied with all performed tests as listed in the summary section of this report.

Technical Report Summary

Type of Authorization :

Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15. The following subparts are applicable to the results in this test report:

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C - Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

Additional documents

The tests were selected and performed with reference to the FCC Public Notice "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, 558074 D01 DTS Meas Guidance v03r03, 2015-06-09".

ANSI C63.10-2013 is applied.

***** FCC and IC Correlation of measurement requirements *****

The following table shows the correlation of measurement requirements for FHSS equipment (e.g. Bluetooth) from FCC and IC Standards.

Measurement	FCC reference	IC reference
Conducted emissions on AC mains	§ 15.207	RSS-Gen Issue 4: 8.8
Occupied bandwidth	§ 15.247 (a) (2)	RSS-210 Issue 8: A8.2 (a)
Peak power output	§ 15.247 (b) (3),(4)	RSS-210 Issue 8: A8.4 (4)
Spurious RF conducted emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13/8.9/8.10; RSS-210 Issue 8: A8.5
Spurious radiated emissions	§ 15.247 (d)	RSS-Gen Issue 4: 6.13 / 8.9/8.10; RSS-210 Issue 8: A8.5
Band edge compliance	§ 15.247 (e)	RSS-210 Issue 8: A8.2 (b)
Power Density	§ 15.247 (a)(1)(iii)	RSS-210 Issue 8: A8.1 (d)
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	- - -	RSS-210 Issue 8: 2.3; RSS Gen Issue 4: 5 / 7 *)

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30-960 MHz or if these are scanner receivers.

Description of Methods of Measurements

Conducted emissions (AC power line)

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10,

Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.10.

The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 μ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads. The measurement procedure consists of two steps. It is implemented into the EMI test software ES-K1 from R&S.

Step 1: Preliminary scan

Intention of this step is, to determine the conducted EMI-profile of the EUT.

EMI receiver settings:

- Detector: Peak - Maxhold
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF-Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- Measurement on phase + neutral lines of the power cords.

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement

Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.

EMI receiver settings:

- Detector: Quasi-Peak
- IF - Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:

- 1) Neutral lead - reference ground (PE grounded)
- 2) Phase lead - reference ground (PE grounded)
- 3) Neutral lead - reference ground (PE floating)
- 4) Phase lead - reference ground (PE floating)

The highest value is reported.

Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dB μ V)	AV Limit (dB μ V)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

Used conversion factor: Limit (dB μ V) = 20 log (Limit (μ V)/1 μ V).

Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements. The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 3
- Detector: Peak / Sample (6 dB bandwidth / 99% bandwidth)

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (2)

Systems using digital modulation techniques may operate in the 902-928 MHz and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Used conversion factor: Output power (dBm) = $10 \log (\text{Output power (W)} / 1\text{mW})$

Peak power output

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT. The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Detector: Peak

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (b) (3)

For systems using digital modulation techniques in the 902-928 MHz and 2400-2483.5 MHz bands: 1 watt.

=> Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

Used conversion factor: Limit (dBm) = $10 \log (\text{Limit (W)}/1\text{mW})$

Spurious RF conducted emissions

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Detector: Peak-Maxhold
- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: 330 s

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance" (cf. chapter 3.6). This value is used to calculate the 20 dBc limit.

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power

Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10,

Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration.

The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

The measurement procedure is implemented into the EMI test software ES-K1 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT.

The final test on all kind of EUTs is performed at 2 axes. A pre-check is also performed while the EUT is powered from both AC and DC (battery) power in order to find the worst-case operating condition.

1. Measurement up to 30 MHz

The Loop antenna HFH2-Z2 is used.

Step 1: pre-measurement

- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 – 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF-Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.

- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF-Bandwidth: 200 Hz – 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 μ s (BT Timing 1.25 ms)
- Turntable angle range: -180 to $+180^\circ$
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: -180 to $+180^\circ$
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by $\pm 22.5^\circ$ around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by ± 25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: -22.5° to $+22.5^\circ$ around the determined value
- Height variation range: -0.25 m to $+0.25$ m around the determined value

Step 4: final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:

- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

The measurement distance was reduced to 1.4 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a standard gain horn antenna (18–25 GHz) are used, the steps 2–4 are omitted. Step 1 was performed with one height of the receiving antenna only.

EMI receiver settings:

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.
For the enhanced data rate packets the test is performed as worst-case-check in order to verify that emissions have a comparable level as found at basic data rate. Typically, the measurement for these packets is performed in the frequency range 1 to 8 GHz but it depends on the emissions found during the test for the basic data rate. Please refer to the results for the used frequency range.

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (d)

... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency (MHz)	Limit (μV/m)	Measurement distance (m)	Limit @ 10 m distance (dBμV/m)
0.009 – 0.49	2400/F(kHz)	300	48.5..13.8 + 59.1 dB = 107.6..72.9
0.49 – 1.705	24000/F(kHz)	30	33.8..23.0 + 19.1 dB = 52.9..42.1
1.705 – 30	30	30	29.5 + 19.1 = 48.6

Frequency (MHz)	Limit (μV/m)	Measurement distance (m)	Limit (dBμV/m)
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§15.35(b)

..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit...

Used conversion factor: Limit (dBμV/m) = 20 log (Limit (μV/m)/1μV/m)

Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10, FCC §15.31

Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements:

1. Show compliance of the lower band edge by a conducted measurement and
2. show compliance of the higher band edge by a radiated and conducted measurement.

For the first measurement the EUT is set to transmit on the lowest channel (2402 MHz). The lower band edge is 2400 MHz.

Analyzer settings:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

For the second measurement the EUT is set to transmit on the highest channel (2480 MHz). The higher band edge is 2483.5 MHz.

Analyzer settings for conducted measurement:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

EMI receiver settings for radiated measurement:

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

Test Requirements / Limits

FCC Part 15.247 (d)

"In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

...

Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c))."

For the measurement of the lower band edge the RF power at the band edge shall be "at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power..."

For the measurement of the higher band edge the limit is "specified in Section 15.209(a)".

Power Density

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Detector: Peak-Maxhold
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

Test Requirements / Limits

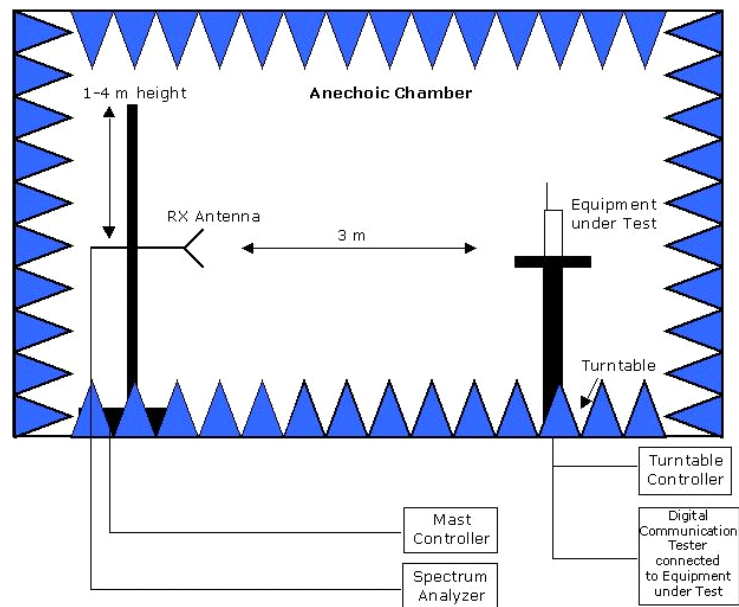
FCC Part 15, Subpart C, §15.247 (e)

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

...

The same method of determining the conducted output power shall be used to determine the power spectral density.

Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces

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